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Ragnar's Homemade Detonators:
How to Make 'Em, How to Salvage 'Em, How to Detonate 'Em!
by Ragnar Benson

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Contents

Warning

The manufacture and/or possession of explosives and explosive devices is *illegal* without proper federal, state, and local authorization.

Construction of homemade blasting caps is one of the most dangerous and ill-advised procedures in the field of improvised explosives. The resulting end products are extremely unstable and unpredictable. Whenever dealing with high explosives, special precautions must be followed in accordance with industry standards for experimentation and production. Failure to strictly follow such industry standards may result in harm to life and limb.

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Preface

Since I wrote *Ragnar's Guide to Home and Recreational Use of High Explosives* and *Homemade C-4*, probably not a single week has passed that a reader has failed to write pointing out an obvious truth. "All of the formulas and techniques are great," readers say, "but what happens when we cannot purchase or otherwise acquire common commercial blasting caps? We miss all the fun of hearing the well-muffled 'thump' of explosives doing the work and of seeing great boulders, buildings, or machines propelled skyward."

Certainly a valid comment, since no explosive is useful if one cannot find a safe and effective method to detonate it. It would also be a plus if the method of detonation was fairly cheap and simple.

While I alluded to a detonator formula in *Home and Recreational Use*, it was my purposeful intent not to elaborate. The exact means and methods of chemical formulation and mechanical construction were handled only briefly. By so doing, those already familiar with explosives who also had previously learned caution could explore these ideas based only on a general sense of direction which I provided. This was an important decision, since home construction of blasting caps is extremely dangerous.

The U.S. Bureau of Alcohol, Tobacco, and Firearms (BATF) estimates that fully 30 percent of the bomb explosions that occur in the United States each year involve inex-

perienced home-builders whose concoctions accidentally, prematurely, and destructively detonate—often with tragic results. Chances of this happening while home-brewing blasting caps is at least 100 times greater than when mixing up common explosives. This is especially true of homemade C-4, which, even in its completed form, is relatively stable and long-lived.

Blasting caps, by nature and definition, contain a very fast, very powerful explosive. Only an extremely small amount is found in each cap, but the material is easily detonated by mild shock, slight warming, or tiny amounts of static electricity. The heat from a single light bulb, for instance, can detonate dried blasting cap explosive.

There are, for instance, approximately 28 grams in an ounce. Even amounts of cap explosive as tiny as 1 gram, or 1/28 ounce, can mangle a hand. Again, these explosives are also extremely fast, adding immeasurably to their danger.

As a result, it did not seem appropriate to unduly jeopardize faithful readers who, at this time, possessed insufficient skills to keep themselves from being splattered all over the walls. On the other hand, if a maker of C-4 knew where to purchase commercial caps, he would—the reasoning went—also have the expertise needed to stay out of trouble should he actually decide to go ahead and fire his home brew off.

However, I had not counted on Big Brother getting into the business of forcing people to purchase and use explosive detonators. By model year 1999, all passenger cars and trucks sold in the United States must be fitted with costly, complicated, and often ineffective air bags. These air bag systems contain, at their heart, an electric blasting cap as well as a large charge of sodium azide booster. Big Brother will probably react to this book, mandating some other air bag deployment system, but as of this writing, air bag owners are electrical blasting cap owners as well.

While blasting caps are extremely expensive and mechanically difficult, those who absolutely, positively had to have one could get it from an automotive air bag assembly. To some extent, these caps lack the strength and quality of regular commercial blasting caps, but for those who cannot scrounge up the simple chemicals needed for good homemade caps, they are an option.

An air bag from a 1991 Chevy was torn down in preparation for this book. As presently constructed, air bag detonators are sealed in such a manner that their removal and deployment is an arduous, often unrewarding chore. At $800 each as dealer replacement parts, these caps are probably not practical for this use. Nevertheless, it seems typically inconsistent for the government to attempt to regulate purchase of blasting caps and then require that between one and four of them be permanently mounted in a vehicle carrying one's family about town. I won't even allow my wife and children to ride in the same vehicle with commercial blasting caps!

Readers will find that home construction of blasting caps "from scratch" is reasonably easy once one has the basics down. Yet it is an intricate, often time-consuming process wherein great attention must be paid to detail. The challenge involves doing the work while still retaining all of one's fingers and a portion of one's hearing. Hopefully, readers will continue to treat the information that follows as general, recreational-type reading and will not attempt to actually construct a blasting cap—at least until they have acquired a great deal of experience with and respect for all explosives.

Introduction

A close friend living on the coast won a huge, pink, overstuffed toy lion at the county fair. Instead of being content to do traditional things with it, such as give it to a wife or girlfriend, he took it to the shooting range. While his friends' attention was distracted, he cut the back open and pulled enough cotton out to allow the insertion of four sticks of commercial dynamite. Large safety pins did a reasonable job of closing the wound. His friends were unaware of the scam in progress.

Following a great deal of B.S. about organizing a lion hunt, the guy packed his specially stuffed lion out to the 200 yard line on the range. Back at the bench, he solemnly proclaimed that those with wimpy .270s, .308s, and .30-06 rifles could not "kill" this lion. "Takes a real man's gun like my .338," he needled them.

His friends blasted away for a few minutes. What rounds hit the toy lion at that range did so in the head and shoulders. Miraculously, no round found the dynamite below. Finally, the guy hunkered down with his .338, aiming for the bottom third of the target.

His first round found the powder, blowing shards of cotton stuffing, fluffy pink skin, glass eyes, ears, and nose over about 10 acres. It also severely startled his unsuspecting friends and several others on the range that day.

For most of them, it was their first real non-Hollywood

experience with explosives. Like most Americans, they concluded that it was jolly good fun, the only downside being their collective lack of understanding as to how these things really work. All present became more interested in the work and recreational aspects of explosives.

The information that follows zeroes in on only one aspect of using explosives successfully. It is, however, a key step that, judging by my mail, is relatively obscure. This book explains how to make blasting caps in an emergency context.

Before one can even contemplate the manufacture of blasting caps, it is vital that he acquire a good understanding of the concept of primary ignition in explosives. Primary ignition is understood by most outdoorsmen today, but it was actually first discovered in 1863 by the father of modern explosives, Alfred Nobel.

Nobel placed a tightly sealed tube of black powder inside a can of nitroglycerine blasting oil. A fuze led into the black powder. Fired fuze alone would not reliably detonate the nitro, even though the material of that age was overly sensitive and unreliable.

Primary ignition refers to the concept that a tiny bit of relatively unstable, high-intensity explosive can be used safely to detonate relatively stable explosive compounds. If a primary ignition system is used, waxes and clay can be added to sensitive secondary explosives to stabilize them for transportation and deployment. Then very fast, easily detonated mixtures can be used in very small amounts to make the whole batch go. In some cases, two booster stages are employed, leading to final detonation of the main explosive charge. This is, in fact, what occurs when commercial powder handlers use a cap to detonate primer cord which, in turn, is wrapped around a block or more of C-4.

Today, sportsmen use the concept of primary ignition to detonate extremely stable cartridge powders without giv-

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ing the process a second thought. But during initial work on high explosives in the late 1800s, problems included both finding a safe way to detonate and keeping one's explosives from detonating spontaneously while sitting on the shelf.

Before Nobel's work, black powder was ignited (not detonated) by direct insertion of a fired match or something similar into the main powder mass. Cannoneers used a fired wick, and sappers had to light the fuzes on their breeching charges. The only slight concession or transition was the advent of percussion caps, a blow to which would set off the main charge.

Black powder is sufficiently combustible so that it will go off when electrically ignited properly. Yet black powder cannot develop the shock, pressure, and speed necessary to quarry rock, destroy cement, or punch through steel. More powerful high explosives were developed for this purpose.

Although the concept of primary ignition was poorly understood at the time, its discovery was vital. Nitroglycerine, in its commercial form, was far too stable to be of any use in the field. A match might cause it to burn with an oily, low, brief flame, but unless large quantities were present, usually no detonation resulted. Even today, given our great strides in the fields of chemistry and mechanics along with our ability to exactly refine compounds, it is the blasting caps that are still considered to be dangerous, not the dynamite, military explosive, and/or blasting agent.

Tiny, insignificant-looking blasting caps, no bigger than a firecracker, detonate from heat, static electricity, or from being dropped, and they do so with enough intensity to take out eyes, fingers, or ears. This is true despite the fact that caps contain no more explosive than the tip of a regular wood "farmer match."

Constructing homemade caps must be considered a two-part exercise—mechanical and chemical. Techniques are not

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difficult or mysterious. They do, however, require that the maker pay meticulous attention to detail. The purpose is always to produce an effective device that will perform the work of primary ignition in a reasonable, safe manner. At times it is difficult to remember one's ultimate objective.

Unlike commercial blasting caps, homemade caps can be made as needed and then be "boosted" by inclusion of extra detonating material. These more powerful caps work well with sleepy homemade or military-grade explosives, both of which can be quite difficult to detonate.

In preparation for this book, 54 prototype blasting caps were constructed. Most went off with a nice report, but none would detonate commercial explosives. Despite numerous attempts to compress or enclose the primary mixtures, all were too slow to do the work. Most provided enough power to throw pieces of dynamite from shattered cartridges, but they simply would not detonate the powder. And experienced explosives handlers know that, compared to military or homemade C-4 or any other military explosive, commercial dynamite is relatively easy to detonate.

Not all was lost. The process provided valuable instruction relative to ignition devices, bridge wires, drop wires, insulation, and crimping. In an attempt to hold all variables to an absolute maximum, we did not try to make more than one component at a time, and no experiments were done with match-lit fuze and cap systems. Safety fuze is extremely difficult to make at home, and a successful electric cap could always be changed over to safety fuze if necessary, we reasoned. In the course of the discovery process, we were able to expose a great many fables and old wives' tales regarding detonating explosives.

Pyrodex P grade powder, for instance, is roughly equivalent to FFFG black powder. It will detonate with a pleasant, resounding "thump" when fired electrically. Yet even when used in large quantities and tightly compressed in an

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old .338 brass case, it lacked sufficient pizzazz to explode commercial dynamite. We virtually carpeted the backyard with dynamite crumbles from shot-but-not-detonated charges. Not only did we waste caps and dynamite, we used up an incredible block of time.

Mixtures of Pyrodex with Bullseye and washed, ground ammonium nitrate were equally disappointing. Even when tightly packed, these materials either failed to detonate or did so anemically. The only result was to distribute more expensive dynamite around the place.

While progress with chemical portions of the process was proving to be elusive, we were getting our numbers down relative to mechanical constraints. In some regards, the mechanical component of a blasting cap is as tough a nut as is the chemical half. Yet eventually, using only common, inexpensive components, we were able to devise an excellent homemade blasting cap that nicely detonated common explosives.

A vital part of detonation in a field sense involves the use of clever, effective, easily constructed trigger mechanisms. It doesn't take a rocket scientist to realize that, along with proper caps, one must have a safe detonating system. In that regard, we have scrounged the world over for good, useable trigger mechanisms to include in this volume. These should comprise the latest, most clever thoughts on the matter.

What follows is a distillation of this huge, time-consuming research project in which we searched most available literature, talked to dozens of the best survival-type improvised explosives experts, and built numerous prototypes. Some of the following information is even contained in obscure military manuals.

Again, I wish to thank those who assisted in Denver, Colorado; Sitka, Alaska; and even Morristown, Tennessee, and to apologize to my neighbors, who, by now, must be

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powerfully tired of the constant roar of detonating powder as seemingly endless experiments take place.

1 Mechanical Construction

It's the hen-and-egg syndrome. Do home-builders start with the chemical heart of their device or with the external skin and bones? Because more than one chemical formulation can be used as blasting cap primer, it would seem appropriate to start with the tubing and wire mechanical portions of the project. This first step is similar no matter which chemical builders ultimately install inside their caps.

As mentioned, safety fuze is difficult and dangerous to home-build. Unreliability of homemade fuze raises the risk, in the opinion of most handlers, to unacceptable levels. What follows relates only to electrical detonating caps.

The mechanical intricacies of caps are not difficult to understand, but construction details must be followed with great vigor lest the results be erratic and dangerous. Skipping a step or scrimping on execution because one is busy, inept, or lacks correct materials just won't cut it. In most cases, extensive and perhaps boring explanations are included, explaining why a process must be undertaken as outlined.

No dynamite cap, for instance, should ever be built using copper tubing, brass or copper cartridge cases, or metallic tamp sticks. Reactive salts within the peroxide-based primer mixture can easily cause unwanted chemical reactions with the metal. In an absolute emergency when nothing else is available, copper tubing can be used for cap cases, *but only if these caps are deployed in a day or two at most.* After two weeks

Quarter-inch aluminum tubing used to make the body of the detonator. A 3-foot length can be bought in hobby shops for $2.

of storage, caps with copper hulls can be expected to start self-detonating on the shelf or when moved slightly. Handling by any means after more than a few hours after assembly will be tragic.

Using a small tube cutter, cut sections of tubing into 2 1/2-inch segments

Use 1/4- or 7/32-inch thin-wall aluminum tubing available from hobby shops for about $2 per 3-foot section. This tubing is commonly used by model builders to construct landing gear for planes. Using a small, gentle tube cutter or very fine hacksaw blade, cut into 2 1/2-inch lengths (overly long compared to commercial caps, but the added skirt length allows one to keep one's fingers away from the main cap charge). These are the cap bodies.

Purchase a box of wide-diameter common plastic soda straws. These straws should slip down inside the 1/4-inch

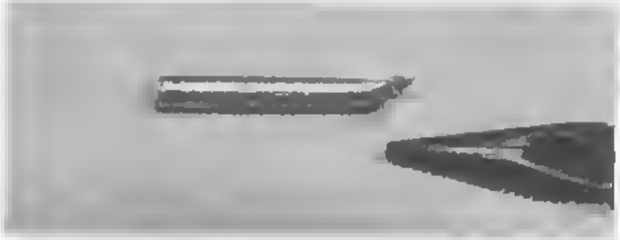
Regular plastic soda straws are used as liners to keep corrosive chemicals from reacting with metal in tube body.

tube sections without leaving very much free space. Such plastic soda straw liners for the tube bodies provide an added measure of protection against the priming mixture reacting dangerously with the metallic bodies, even when aluminum is used. Some dynamite cap home-builders who can purchase only copper or brass tubing successfully use plastic straw liners to hold their reactive primer mixtures in check. Yet this is far from ideal and not recommended except in an emergency.

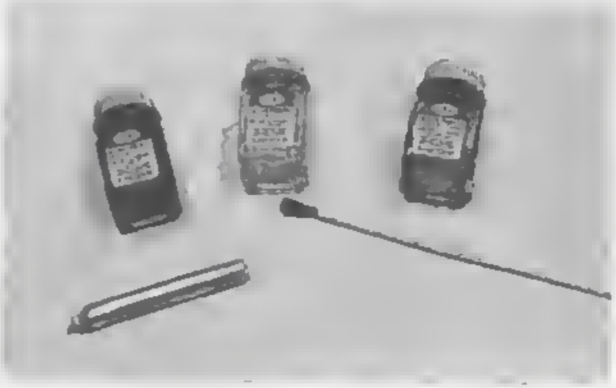
After inserting a 2 1/2-inch plastic straw segment into the aluminum tube piece, use long-nosed pliers to crimp one end of the tube securely. Keep the crimp short, neat, and pointed, as a clean point will facilitate insertion into the explosive mass later.

The straw segment lining inside of the aluminum tube should now be crimped in at the bottom of the tube as well. The crimp must be as tight as possible, precluding drying air from getting in and chemical from exuding out.

Place two or three drops of clear lacquer model paint,



Insert segment of plastic straw in end of aluminum body, then crimp to a point with pliers.



Use model enamel or finger polish to seal crimped end of cap body, including any breaks in soda straw.

nail polish, or other liquid sealer all the way down to the bottom of the cap body. This will finish the seal at the end of the cap, help bond the straw segment to the aluminum body, and overcoat any breaks in the straw created by the crimping operation. Check with a small light, being sure

Nickel chrome wire purchased in hobby shops becomes the basis for bridge wire. Use .015 to .020 diameter if possible.

the lacquer ended up at the bottom of the tube body.

Set the assemblies aside for four hours to dry thoroughly. While they are drying, start on the actual ignition assembly, called the bridge wire. Like other parts of these caps, this component is deceptively simple, but it is nevertheless critical that it be built as directed.

Bridge wires are the heat element in caps which, when shorted to a battery, glow red, causing detonation of the primer material. Smaller-diameter wire is, in most cases, desirable since it can be more easily heated with smaller batteries, but the wire must be of sufficient size to create enough heat for a detonation. In all cases, the progression must be larger drop wires to large leg wires to tiny bridge wires in the cap. The thin wire acts as a kind of fuze, heating up and eventually opening the circuit, causing the cap to detonate. If all wires in the circuit are the same size, they will all tend to heat uniformly, draining the power supply without detonating the cap.

Use only high-grade nickel chrome wire employed by model builders to home-turn small springs. Generally, diameters of between .015- and .020-inch are best, but if one has a less sensitive primer, more powerful batteries must be used with heavier wire. Anything over .025-inch diameter will probably blow fuzes in a residential electrical system. This is definitely the upper size limit for bridge wires.

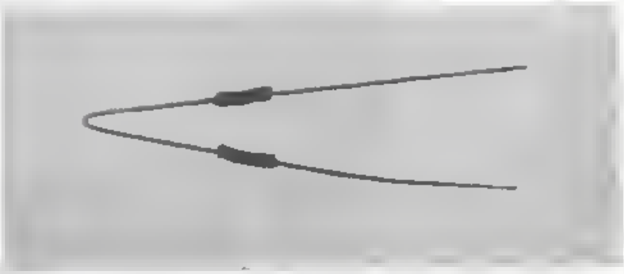
Cut a piece of nickel chrome spring wire about 6 inches long. Bend it into a hairpin, using pliers if necessary. Using a screwdriver, small punch, dull cold chisel, or, as neces-

Gently cut a shallow notch in end of bridge wire that touches detonator chemical. This ensures detonation at this point.

sary, a wire cutter, gently place a small notch in the wire at the bottom of the U. This notch causes the wire to burn through at the place where it touches the priming charge. (Nickel chrome wire will sparkle nicely in the process of melting down.) It is an important step. Without a notch, the entire wire might melt, causing a delayed detonation, or a leg wire might burn off, totally preventing detonation. Bridge wires may also short together and burn off outside the cap, opening the circuit before detonation is achieved.

Strip 3/4-inch pieces of wire insulation from electrical cord to insulate the bridge wire.

Using an electrician's wire stripping tool, remove two 3/4-



.020 bridge wire bent with two insulators slipped in place.

inch pieces of insulation from a piece of common appliance wire. Take them off as cleanly and neatly as possible.

Slip one piece of insulation onto each side of the bridge wire assembly. These pieces act as added insulation so that the hot wire does not short out either through the plastic soda straw into the piece of aluminum tube or to each other above the notch. After the priming material is packed into the tube, the bridge wire assembly is inserted firmly down into the primer in the bottom of the tube, the wires turned down, and the tube sealed (more on this in Chapter 3).

Builders who do not have access to aluminum tube or nickel chrome wire can use a standard PR-6 flashlight bulb. Carefully crack the glass away, leaving the filament perfectly intact. Solder a wire lead to the back end and side of the bulb. Carefully place the intact filament into the priming mixture. It isn't as good as nickel chrome wire, but it will work.

Assuming the lacquer sealer is now dry, it is time to mix up the priming mixture. Doing so is the subject of the next chapter.

They Don't Want You to Know about This Primer Mixture

2

Other than a slight danger of getting one's finger caught in a wire stripper or cut on a tube rim, producing cap bodies is not particularly dangerous. This is definitely not true for the chemical portion of this project. Very small amounts of this primer can do great damage.

Consider this incident. After filtering a batch of primer mixture through a paper coffee filter, I scraped all of the white precipitate paste I could into a black plastic film container. Nothing visible was left on the paper filter. The next morning, the disheveled paper was as dry as the proverbial bone.

When I struck it with a heavy metal hammer on a wooden work bench, nothing happened. Casually, I placed the filter on my steel vice and hit it another lick. This time it was steel to steel. A great, brittle, tearing-type explosion blew the paper into a million flimsy shards, scattering them about my entire shop.

Ten minutes of shop-vac time returned the room to normal, but the incident was a good lesson.

Any primer mixture is, by definition, very sensitive, and it is also fast and powerful. One is not working with wimpy black powder in this case. Anyone who might decide to actually produce this material at home should make only *tiny* batches at any one time.

Three relatively easily acquired chemicals are used to produce a primer mixture. These are hexamine, citric acid,

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and common hydrogen peroxide. The chemicals required are so simple they almost rival home manufacture of C-4.

The first chemical used is common hexamine. It is available from camping supply outlets.

Hexamine is a white, crystalline solid compressed into small tablets. It is made by evaporating a mixture of formalin solution and laundry ammonia. Fairly half-hearted attempts to produce it at home were unsuccessful. No doubt hexamine could be home-made, but, at this time, it was too much bother and expense.

Perhaps because it can be made into primer material as well as other high-grade explosives, standard hexamine is increasingly more difficult to find in stores. Traditionally, boy scouts among us have used it for fire in their little camp stoves. In the past, it was easy to purchase almost anywhere.

Yet hexamine can be purchased locally at army-navy stores, surplus houses, and in some yuppie-type camping/mountaineering outlets. Some druggists have or can get it, and there are always mail-order outlets such as SI Outdoor Food and Equipment Co. (Box 1279, Provo, Utah 84603). A company called Safesport Manufacturing In Denver, Colorado, imports it from Belgium.

Hexamine is $C_6H_{12}N_4$, properly named hexamethylenetetramine. It is marketed as a medical preparation

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Using a mortar and pestle, grind a hexamine tablet to fine powder.

under the trade names of Hexamine, Methenamine, Cystamine, Cystogen, and Urotropine, and is taken by mouth as an antiseptic for the urinary tract. Manufacturers use it to manufacture plastics and vulcanize rubber.

Hexamine can be treated with 100-percent nitric acid, producing a material very much like PETN. The process is extremely hazardous because of heating of the mixture and because the material produced is highly unstable until mixed with wax, homogenous clay, or diatomaceous earth. Even those who can find or home-produce nitric acid are advised to let this one pass because of the danger . . . unless, of course, they are excellent chemists.

When it can be found in the store, hexamine is extremely inexpensive. A tube containing six large tablets—providing

enough material for about 20 homemade blasting caps—costs about $1. Thus it is hardly worth fooling around with home manufacture unless hexamine becomes completely unavailable.

Using a common mortar and pestle, fine-grind the hexamine tablets into a dusty, talcum-consistency powder. There is little danger in this process, especially when one handles only relatively small amounts of hexamine at any one time.

Powdered citric acid found in canning section of the supermarket is the second chemical used in detonator compound.

Place one teaspoon of pulverized hexamine in a sturdy pint jar for which a good, tight plastic or plastic-coated twist cap is available. Place two teaspoons of dry citric acid powder in the jar with the single teaspoon of hexamine. Citric acid is available in home-canning sections of grocery stores, drugstores, and even health food stores. Cost, at this writing, is about $6.50 for 4 ounces of the dry, white powder.

To this dry mixture, add 1 ounce (about 4 1/2 teaspoons) of hydrogen peroxide. This is the same material sold in drugstores and used in beauty salons to bleach hair. In dilute solutions it is used as an antiseptic.

Drugstore peroxide (H_2O_2) is usually only 3 percent concentration. This is too dilute to be of much value to home detonator builders. Either 30- or 35-percent solutions can be special-ordered at most drugstores (except the very large chains, which no longer seem interested in customer

Hydrogen peroxide in 30-percent strength comprises the third chemical in the primer mix.

service). Cost is about $18 per pint. A pint will make a huge number of caps but will deteriorate after only a year or so on the shelf. Place the brown bottle in a dark place to increase shelf life.

Shake the jar containing hexamine (1 teaspoon), citric acid (2 teaspoons), and peroxide 30 percent or more concentration (1 ounce, or 4 1/2 teaspoons) vigorously for 6 to 10 minutes till all of the material goes into solution. Larger batches can generate heat, which will tend to degrade the mixture with a loud "boom." Besides yielding more sensitive explosive than one can safely handle, this is another reason batches of primer mix should be kept very small. Ultrasmall batches tend to dissipate their heat without problems. If heating starts, however, stop shaking and

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One teaspoon hexamine, two teaspoons citric acid, and four teaspoons peroxide placed in a small jar and mixed thoroughly.

submerge the jar in a steady stream of cold, running water.

Place the jar with everything well-shaken into solution in the refrigerator at least overnight. Next day or eight hours later, whichever is longer, a white precipitate will have settled to the bottom of the jar. To some extent it will also swirl around in the solution.

Carefully pour this solution and precipitate through a common coffee filter. Wash the jar out with a splash of commercial alcohol and pour it over the precipitate caught in the filter to clean and dry it. Throw away the filtered liquid with alcohol.

While the white precipitate is still damp and pasty, use a wooden tongue depressor or small stick to scrape it into a plastic film container. About two farmer match heads of volume should remain. This is enough for two standard caps or one double-strength unit useful for detonating

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A small druggist's measuring cup and a set of kitchen measuring spoons work well with detonator chemicals.

homemade C-4. In this pasty, undried state, the mixture can burn violently but does not seem to want to detonate. If one has cap bodies ready for loading, the primer can be placed directly in the caps. If it dries in the plastic container, wet it down with alcohol before proceeding.

This material is now ready for assembly in its final form as a usable blasting cap.

3

Final Assembly

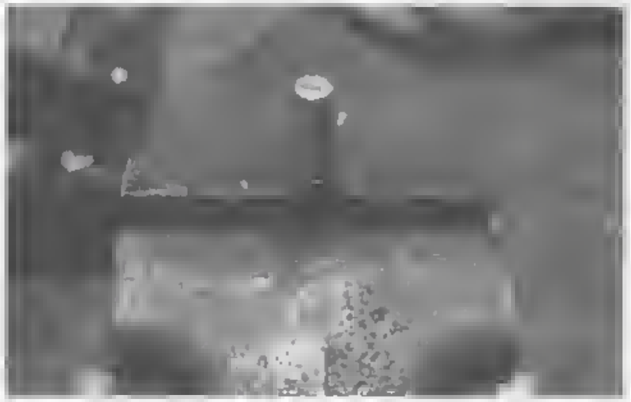
Assuming one has detonator bodies completely made up, including bridge wires with insulation in place, and only a *modest* amount of primer compound ready, proceed as follows.

Cut a .30-06, .338, or 7mm Magnum case off below the neck and fasten it snugly in a vise. This will be a holder for the detonating cap as the primer compound is inserted. *Do not ever, under any circumstances, hold the cap in hand or touch the chemical with a finger during the loading process.* A small, very sharp detonation could occur that would severely damage one's fingers.

Wear a plastic high-impact face shield and heavy leather welder's gloves while loading the primers. If an accidental detonation does occur, it will be semicontained in the soft brass case, and it should be very small as a result of using only small amounts of primer compound. Damage, as a result, should be held to a minimum.

Separate out several small pieces of alcohol-damp primer precipitate totaling a farmer match head in volume (1 gram). If the mixture has dried, add a few drops of alcohol. Use only stainless-steel knife blades to handle the explosive. A third at a time, dump the chemical into the aluminum tube. Use a wooden dowel rod of the correct diameter to compress the mixture into a cake at the bottom of the tube.

Do not thump on the primer. Ease the dowel rod in and



Never hold the cap body in hand while loading. Place it in a cut-off .30-06 casing secured in a vise.

press down with at least 100 pounds of pressure. Place about a third, compress, and then repeat. Again, no more than a total of one match head in volume should be used to equal a standard cap, and no more than two match heads for an oversized detonator for use with sleepy home-brew or military-grade explosives. Anything more places too much sensitive explosive in one place. Decide ahead how much primer goes in each detonator body and then stick to that amount. Be sure to mark oversized caps appropriately.

Check one more time that the bridge wire is slightly notched and that it is not twisted in against itself, which will short it out. Position the insulators so that they will reach up out of the aluminum skirt about 1/4 inch and that no bare wire touches itself or aluminum.

Pushing down firmly, shove the bridge wire loop into the compressed primer mix in the bottom of the aluminum

Use a stainless-steel knife blade to place detonator chemical in body a third at a time. About a match head of volume is used in total.

Tamp down with about 100 pounds of pressure. Wear heavy gloves and face shield.

tube. Be cautious that the bridge wire does not bend and break at the notch.

Leave the unfinished cap in the holder in a safe place where it cannot be disturbed. After 24 hours of curing, carefully place sufficient high-grade silicon caulk in the case to seal the bridge wires away from each other and the edges of the aluminum tubes. Thoroughly seal the end of the deto-

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Place bridge wire down in chemical snuggly. Let it cure in place in the holder for 24 hours.

Place a solid plug of good-quality silicon caulk in the end of the detonator. Be sure the wires are kept separated. Allow to dry 24 hours as well.

nator so that no moisture can get in. These caps are not supposed to be waterproof but probably come very close to being operational underwater. If one needs an underwater cap, carefully coat the entire outside of the unit with fingernail polish.

Be certain that the silicon caulk is completely dry before final work is undertaken. This involves cutting the bridge wire leads back so that only about 1 inch of wire shows through the caulked end of the cap. Using either purchased or homemade wire crimps constructed from 1/2-inch-long,

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Bend bridge wires down, but keep them separated. Cut to about 1 inch in length.

1/8-inch diameter aluminum tubing, secure 12-foot leg wires to the thin bridge wire. Be certain that these leg wires are crimped very securely to the bridge wire so that no separation can occur during handling.

It is extremely important that the leg wires be at least two sizes heavier than the bridge wire.

Using regular or homemade crimps, attach leg wires.

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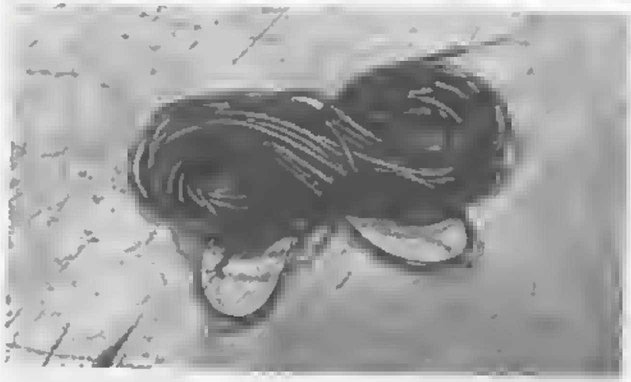

Use heavier-gauge leg wires to attach to bridge wire.

Most home builders use 22-gauge insulated copper for their leg wires. This adds to the cost but is vitally important so that the bridge ignites properly when power is applied. At detonation, only an inch or two of leg wire is chewed off. These slightly shortened wires can be collected and reused after most detonations.

Some home-builders have kept their properly built, well-sealed detonators in storage for up to eight months. However, the better wisdom suggests that they be used within 30 days of manufacture.

Never place two or more caps together physically touching one another or loose in one's pocket. Cut out a styrofoam or foam-rubber holder that will fit nicely inside a tin can. Carry no more than three caps at a time in one of these containers.

Keep all leg wires neatly rolled up and tied together as a deterrent against errant radio transmissions that could cause premature detonation.

When deploying, do not force the caps into the main

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charge. Using an appropriate-diameter tool, awl out a suitably large hole to accept the cap easily. As with any cap, commercial or homemade, bind it into the cap charge so that it is not dislodged easily.

Should one actually attempt to home-manufacture detonators, a great many practice prototypes should be made up first. Check to be certain that bridge wires are the correct diameter for use with one's intended power supply and primer mixture before trying with actual explosives.

Formulas exist to determine the number of caps that can be fired from a given power source, but it would seem wise to fire few caps from a strong source such as a vehicle battery while the engine runs rather than attempting to hook up as many as possible.

An Alternative Primer Mixture

4

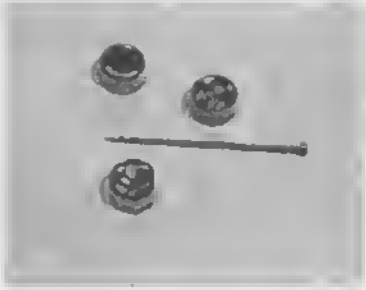
Home-builders who either flunked high school chemistry or are just plain paranoid about compounds need not despair. A reasonably common premixed detonator material is available over the counter. In some places such as New York, California, and Havana it may be easier and simpler to obtain individual chemicals but, nevertheless, an excellent alternative does exist.

We can be thankful, in this case, to Mr. Leroy Moody, a terminal fruit-loop who thought he could redirect American society by sending federal judges bombs in the mail. He would have been better advised just to try bribing judges, but that's another story unrelated to explosives.

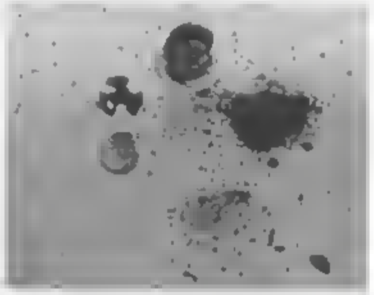
What follows is a concept that came from Mr. Moody's fertile mind and was, to an extent, proved in field trials. Also, thanks to the FBI for ferreting out this information and making it available to the public.

The mechanical portions of this alternate method—including bridge wire, overall precautions, and final assembly—are exactly as set out in the previous chapters. If a difference exists, it involves the fact that a slightly smaller bridge wire can be used. Mr. Moody originated the use of a filament from a PR-6 light bulb for his detonators.

Using a small pliers, pinch and deform the thin steel shell on a large pistol primer just enough to remove the star-shaped stamping inside (called an anvil). These



Large pistol primers commonly used by reloaders from which priming mixture for detonators can be salvaged.



Use a pin to scrape out primer chemical. Five large pistol primers yield sufficient material for a standard detonator.

primers are the type that ammunition reloaders use by the thousands in pursuit of their hobbies. When necessary, use a pin to pick out the small, stamped steel piece and the paper cover below it.

Scratch the chemical compound out of the now-exposed cup interior. This material will tend to be caked into the cup, as it is installed as a paste. The volume of primer mixture recovered from each little cup will be surprising.

Dump the powder into a shallow, smooth, glazed dish. Set the dish aside out of the way of the ongoing disassembly operation, because occasionally, a primer will detonate when picked with the pin or twisted with the pliers. It's definitely a disad-

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vantage to lose the entire stock in an errant detonation, not to mention the singed eyebrows and mangled fingers that inevitably result.

Primer powder from five large pistol primers is sufficient to make one standard blasting cap. Use the powder from seven disassembled primers to construct one oversized blasting cap necessary with some homemade or military explosives.

Place about three drops of clean water in the dish containing the salvaged primer compound. Employing only a wooden stick or stainless knife blade, mix the material into a thick paste. Add a few more drops of water as necessary.

A small piece at a time, drop the moist mixture into a previously prepared straw-lined aluminum tube. As before, pack as tightly as possible, using a wooden rod. Try to apply about 100 pounds of pressure on each third of the primer as it is installed. Like before, do not hold these primers in hand; place them in a small bracket made from an old shell casing while work is being done on them.

After inserting the bridge wire assembly, allow the open tubes to cure for 24 hours and then seal with caulk. After leg wires are attached, the cap is completed. Although no firm data exists, it is *probably* true that these blasting caps will have excellent shelf life; some home-builders estimate from a year to two years. However, one would hate to experience the far end of that span as a cap goes off spontaneously when picked from the shelf. Too late then to acknowledge, "Gosh, we kept that one too long."

If nothing else, salvaging chemical from pistol primers is an extremely quick, easy method of putting together a blasting cap. It is bit safer than mixing chemicals from scratch, provided one has the idiosyncracies of the mechanical portion of the project thoroughly mastered.

5

Improvised Trigger Devices

No matter if one intends to blow out stumps, shatter rock, remove a layer of topsoil, or demolish an old building (as was so pleasantly done in the film *Lethal Weapon III*), the trick is to achieve positive detonation while the person doing the detonating remains safely out of harm's way. Under some circumstances, one must be truly clever to pull this off successfully.

What follows is a collection of field-proven, field-expedient trigger devices that allow one to "do the work" while remaining at sufficient distance to escape danger. Some of these devices were conceived by extremely clever people.

In all cases, triggering a detonation is simply a matter of completing an electrical circuit, allowing electrical energy to flow to the blasting cap. Prudent handlers deploy their charges and hook circuits together on the outbound loop. By so doing, they are connecting wires together as they leave the scene rather than approaching it. Keep in mind that the government says 30 percent of the bomb blasts that occur nationwide are accidental, and that communist guerrilla leader Che Guevara estimated that half the people they sent to make bombs blew themselves up.

Start with a very simple device used principally as a trip wire and booby trap, but which could be used as a command pull switch. Cut the insulation back 6 inches from the end of two pieces of wire. Twist a loop in the end of both

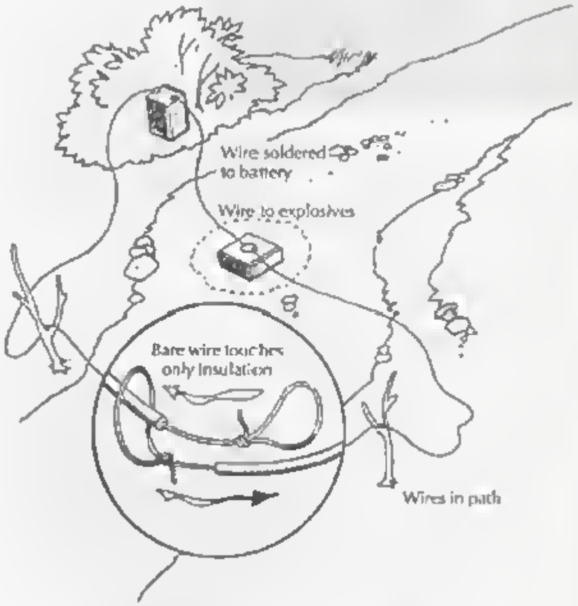

FIGURE 1: TRIP TRIGGER

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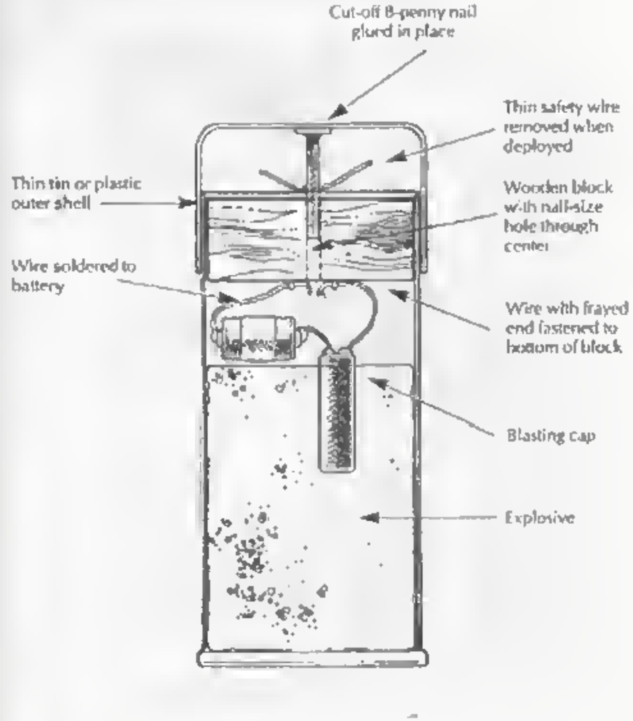

FIGURE 2: POINT-DETONATING FUZE ASSEMBLY

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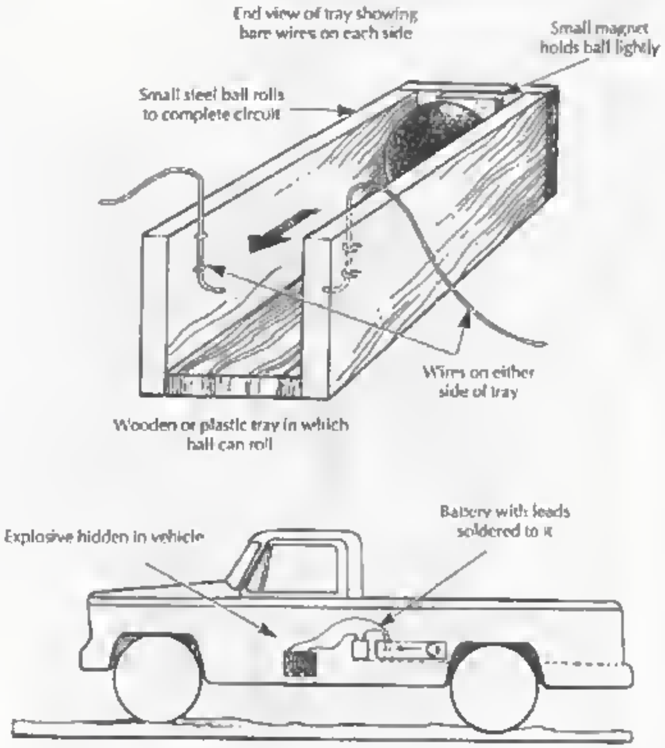

FIGURE 3: INERTIA TRIGGER
* Trigger is used to take out cars and trucks after they leave the motor pool

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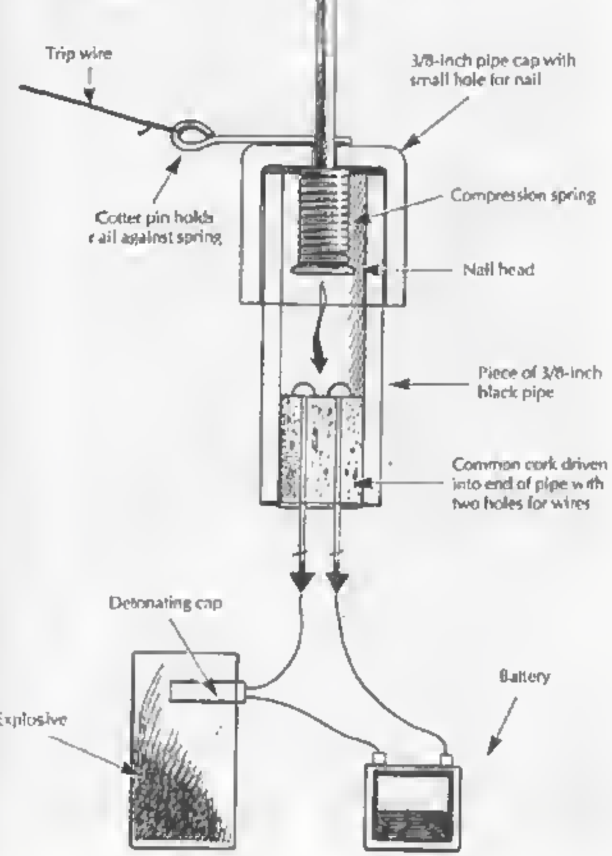
FIGURE 4: MORE CONVENTIONAL TRIP-WIRE TRIGGER PROTECTED FROM ELEMENTS



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wires and place one through another so that only insulation is touching insulation. When moved, bare wire will touch bare wire, completing a circuit. See Figure 1 for a drawing of this basic trigger. As a general rule, it is one of the first that novice handlers should work with.

Figure 2 details a very complex trigger requiring quite a bit of fit and finish. It is also quite dangerous—an errant fumble over a hard surface could blow the place down—yet it is one of the most asked-for trigger concepts. Owners of muzzle-loading cannons and mortars, as well as others, often inquire about a trigger that will detonate a projected round on ground impact.

This trigger requires that one assemble an appropriate nose cone containing a plunger which, when pushed, will make contact between two wires, completing a circuit. Nose cone material must be sufficiently strong to withstand the propelling charge but fragile enough to allow the plunger to plunge.

In Figure 3, a smallish steel ball is held in place in a wooden or plastic trough by a small magnet. This allows one to place a trigger in a vehicle which, when moved uphill or downhill—or through a sudden stop or start cycle—will trigger a detonation. The steel ball breaks free of the magnet, rolling into bare wires. In this case, the charge is transported safely away from the person who deployed it. Applications include any vehicles that stop and start, such as boats, snowmobiles, motorcycles, tractors, and even horse-drawn wagons.

Explosives handlers often require a trip or pull trigger more imperious to the elements than simple looped wires. The one shown in Figure 4 is not submersible, but, properly built, it will withstand a great deal of rain and snow. It is also a bit cleaner than looped wires. Both have performed reliably, selection being a matter of personal choice. Problems involve expense and prior planning required to

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assemble the device. Ideally, users could recover and reuse this trigger time after time.

Wooden spring-activated clothespins make an ideal basis for a number of different triggers. The one shown in Figure 5 has the added advantage of having an arming switch built into the electrical mechanism. Any trigger can be set up with an arming switch, making the entire device a bit safer.

In some regards, use of a mousetrap to trigger a charge when a door is opened is similar to using a clothespin. Some handlers will be able to find mousetraps before clothespins, and vice versa. Figure 6 demonstrates a trigger using a mousetrap as the basis. Variations on this central theme are virtually endless. Users who actually set this up must have an alternate exit from the room.

In all cases, one must be extremely innovative regarding any of these triggers. Figure 7 should get the creative juices flowing among those who might actually deploy explosives. This design is little more than clever use of a simple trip trigger constructed from bare wire loops, used in this case as a booby trap connected to a souvenir, can of food, or official-looking document.

Electrical contacts required to complete detonation circuits need not be klutzy affairs characterized by 18-gauge wire. Tinfoil and light 28-gauge wire can be made to perform quite adequately as improvised triggers, as shown in Figure 8.

Keep in mind that many trigger mechanisms can be deployed backward. In Figure 9, a spring-loaded clothespin is compressed by some action of those detonating the device, making contact, or a mousetrap becomes a spring-loaded completion circuit.

Often, one is better served to rewire simple existing switches to become triggers. These can include doorbells, garage-door openers, light switches of all kinds, and even

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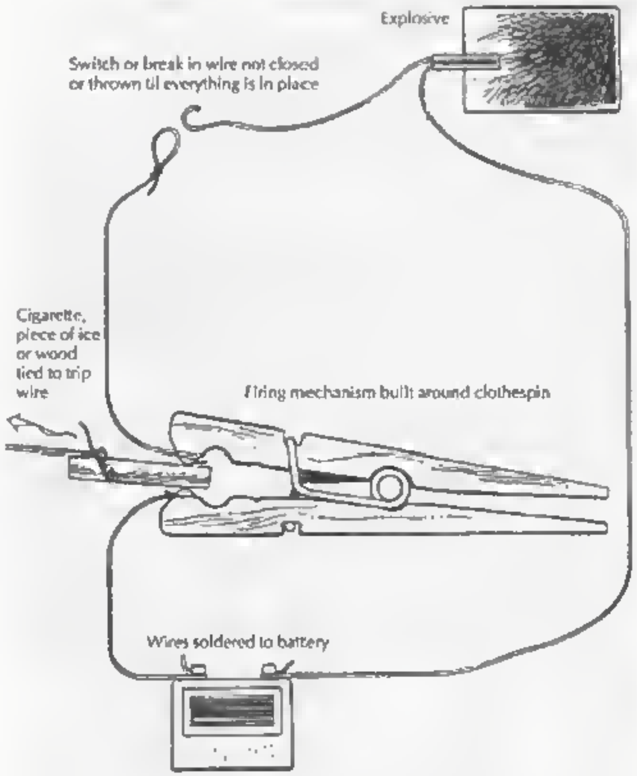

FIGURE 5: TRIP OR DELAY TRIGGER WITH ARMING SWITCH

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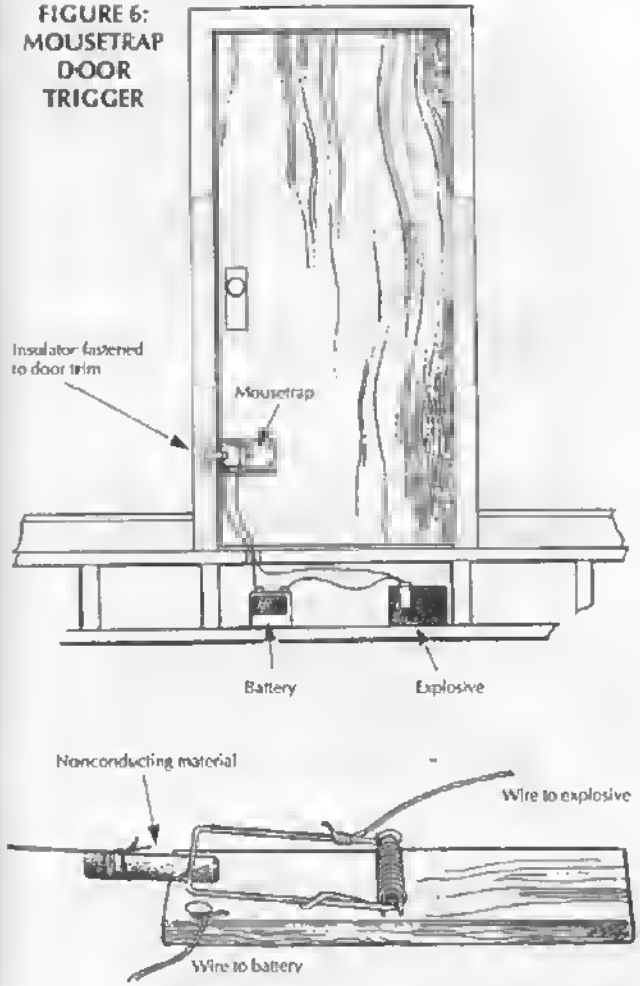
FIGURE 6: MOUSETRAP DOOR TRIGGER



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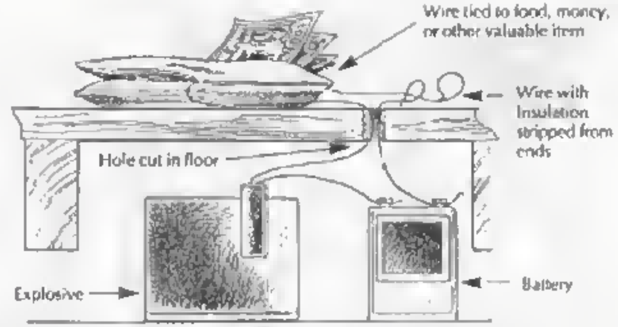

FIGURE 7: INNOVATIVE USES OF TRIP TRIGGER

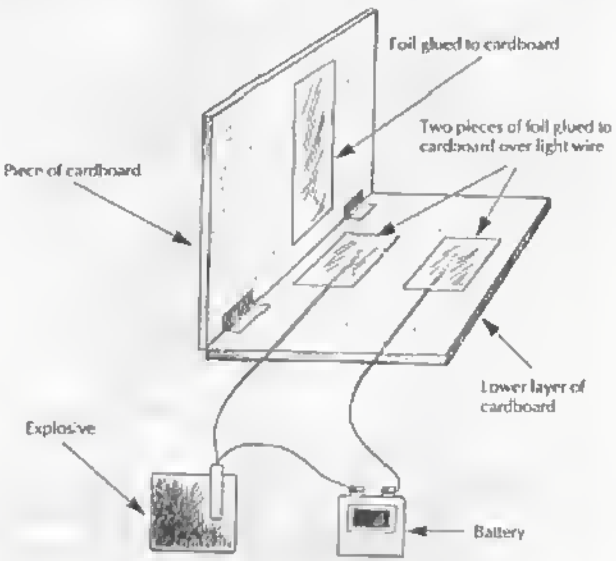

FIGURE 8: FOIL AND WIRE TRIGGER

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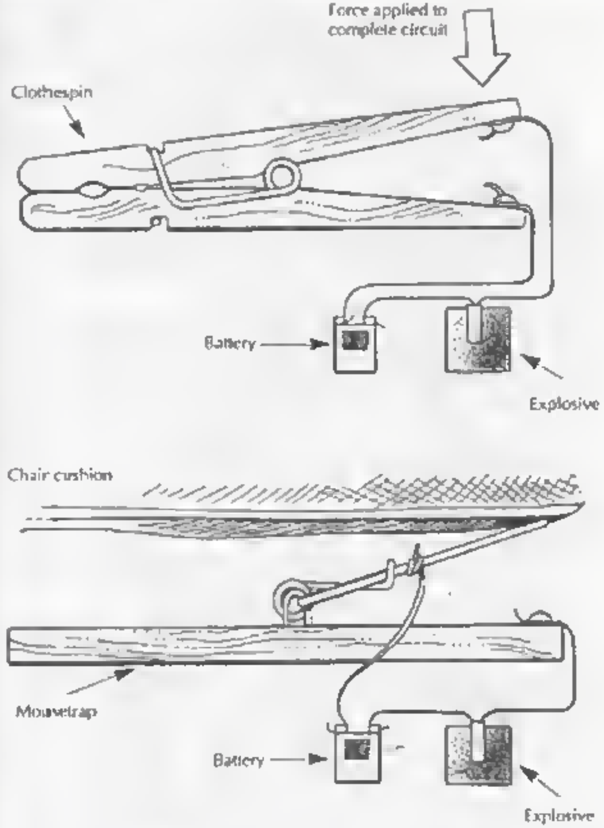

FIGURE 9: TRIGGERS REVERSED TO PRESSURE SWITCHES

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switches on common appliances. Figure 10 demonstrates two more common usages. Instead of batteries, 110-volt household current is available to power the detonators.

In some cases, explosives handlers will require a trigger that will detonate from any movement, even vibration. This is a dangerous circuit that is not to be set up without an arming switch. The switch in Figure 11 can be made from a steel ball available from machine shops and common non-insulated shop wire. Other variations of this trigger are obvious, but this one is the simplest. In this business, simplicity always counts an extra 10 points.

Reliable delay mechanisms are often needed, but they are not immediately obvious unless one is conditioned to think about them. Some make use of components that one would never associate with explosives triggers, such as dried beans, coffee cans, and wine bottle corks. Figure 12 provides some basic concepts to think about.

Readers often inquire about relatively easy manufacture of an inexpensive, thin, pressure-sensitive switch that can be slipped under a door or floor mat, in a chair, or into the trunk of a car, which will detonate when heavy luggage is piled on top. Figure 13 shows such a device.

Use two sheets of heavy-gauge, construction-grade tinfoil to which 28-gauge lead wires have been glued. Place a heavily perforated plastic liner, such as a sink drain tray, between the two sheets. The trick here is to adjust the frequency and size of the holes in the plastic interlayer so that one does not have a premature circuit, yet the circuit will complete after not too much pressure has been applied. Again, it is imperative that one test any device thoroughly and that an arming switch be used at setup.

Bare wires can be fastened with glue or solder to clock hands, doors, or even flush mechanisms on toilets. Any device wherein one can predict exactly when a circuit will be closed will work. Long electric lines require heavier bat-

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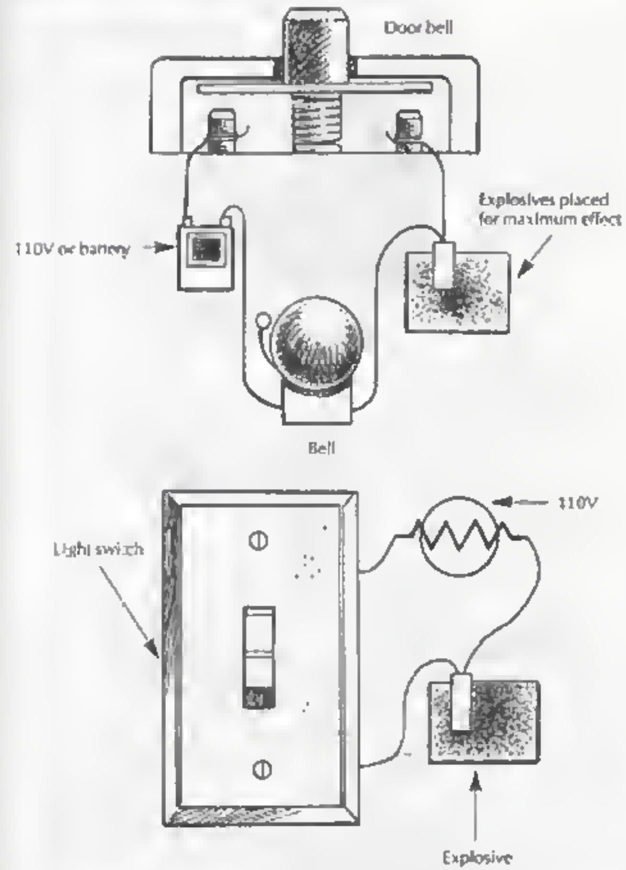

FIGURE 10: COMMON SWITCHES MADE INTO TRIGGERS

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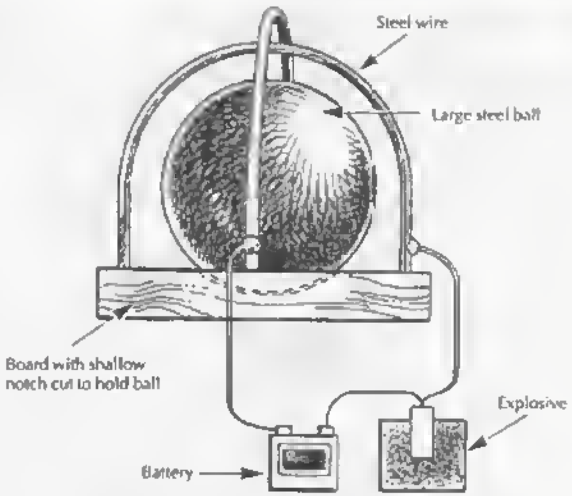

FIGURE 11: MOVEMENT SWITCH

teries but also allow placement of the main charge at the location of greatest utility.

In all cases, attempt to keep the materials and design of whatever trigger is used as absolutely simple as possible. Test extensively without explosives, using a mock device made from a flashlight bulb to determine when the circuit is closed.

All of these triggers are very dangerous and should not be attempted with actual explosives unless one has taken the time to thoroughly understand and test the exact concept with which one is working. Don't ever forget about the 30 percent the FBI knows about and the 50 percent Che Guevara found out about.

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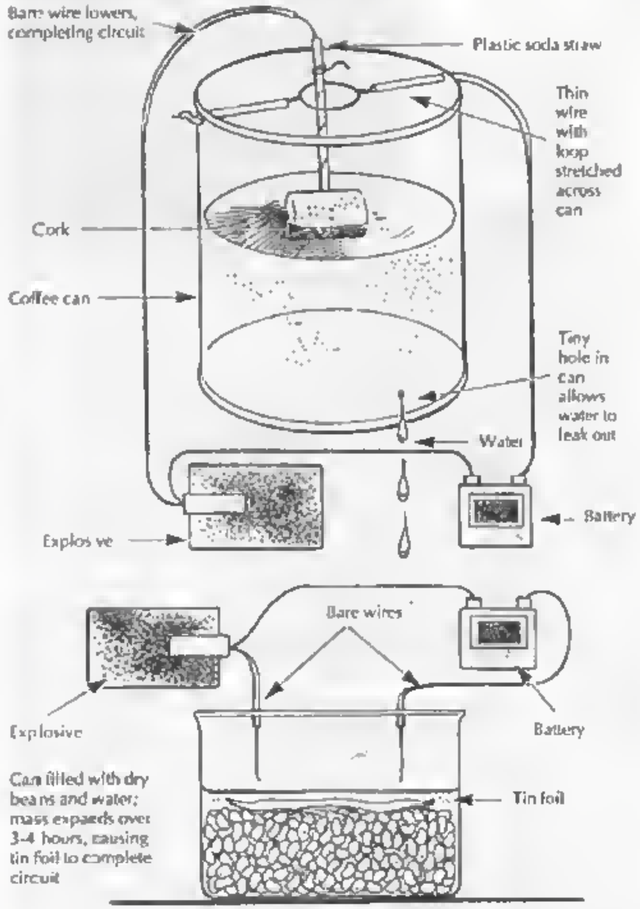

FIGURE 12: RELIABLE TIME-DELAY MECHANISMS

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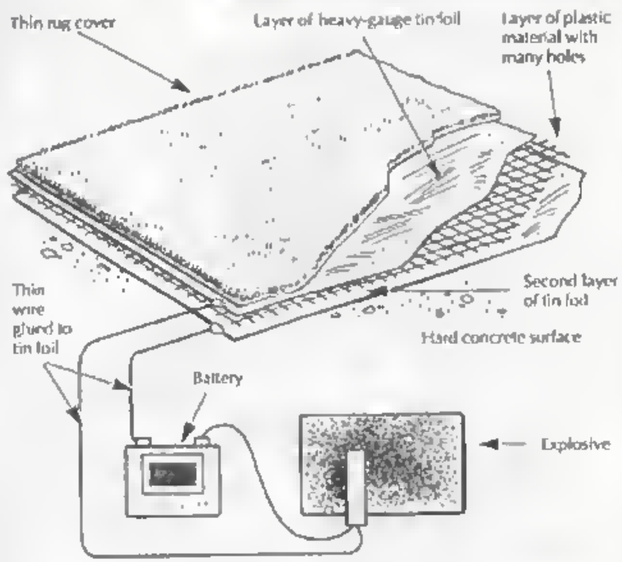

FIGURE 13: THIN PRESSURE TRIGGER
• Foil establishes circuit after being walked upon repeatedly

6
Air Bag Detonators

Few people will be so desperate for a detonating device that they will spend $800 for a new air bag module from which to extract one cap. Yet some may wish to salvage a cap from a junked car and would, therefore, value information as to how this can be accomplished efficiently.

By 1991, cars equipped with air bags were already sufficiently numerous that one could reasonably expect to find an air bag module in a wrecking yard. (See the list on page 49 for cars that are old enough that one could expect to find them junked out.) By 1999, all cars and light trucks sold in the United States will, by law, be equipped with air bags ahead of both front seats. Many experts predict that in the regulatory climate in which we now find ourselves, mandatory rear-seat air bags will not be far behind. Assuming manufacturers do not materially change their mode of construction, there could be four detonator caps per vehicle in the near future.

Most current air bags are mounted with four bolts inside the steering wheel directly over the wheel column, and on the passenger side as a lower knee blocker or under an airbag deployment door.

Deployment is accomplished using an electrical trigger much like Figure 3 in the previous chapter. A trigger mechanism is mounted over each front wheel and in the vehicle center under the dash. Roughly 4/10 second is required to

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blow the bag if the vehicle strikes a solid barrier at 14 mph or greater.

Some vehicles have a delay system allowing deployment of the device even if the battery is destroyed or deactivated at the crash. General Motors models will deploy up to 10 minutes after power is disconnected. Mitsubishi cars reportedly have a delay of up to about half a minute.

Laws regarding reuse of salvaged air bag units are somewhat unclear. Some auto body shops use all of the salvaged units they can find, while others steadfastly maintain one must always buy new. Wrecking yards seem readily able to resell all of the modules they can strip out of their junked autos. It is technically impossible to restuff and rearm a deployed air bag module. In that regard, activator caps and pellets are not available as component parts; one must purchase the entire assembly.

As of this writing, most air bags are deployed by the detonation of an electrical cap specifically engineered to provide a quick, hot blast at relatively low pressure. This cap sets off numerous sodium azide pellets that actually supply most of the air (actually nitrogen gas) to the air bags.

In part because air bag modules, as presently offered, are so extremely expensive, a great deal of research is being done to develop less expensive and perhaps less risky nonexplosive systems. By 1994, most GM vehicles will have a system that uses no electrical detonator or sodium azide pellets. It will be powered by a pressurized cylinder containing argon gas. These devices are, of course, of little value to the survivor. A GM dealer can explain whether a specific vehicle has these new compressed gas systems.

Inspect for a heavy steel cylinder under the dash or on the vehicle's fire wall. Location of the bag itself on the steering wheel or ahead of the passenger will not change.

Start removal of the air bag module by disconnecting the vehicle battery. Wait 15 minutes so that any delay mecha-

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1991 Air Bag Equipped Vehicles

Make	Model	Driver Side	Pass Side
BUICK			
	Roadmaster	std	
	Park Avenue	std	
	Riviera	std	
	Reatta	std	
CADILLAC			
	DeVille	std	
	Eldorado	std	
	Seville	std	
	Fleetwood	std	
	Fleetwood 60	std	
	Allante	std	
CHEVROLET			
	Corsica	std	
	Beretta	std	
	Caprice	std	
	Corvette	std	
CHRYSLER			
	All	std	
DODGE			
	Shadow	std	
	Spirit	std	
	Daytona	std	
	Dynasty	std	
	Stealth	std	
FORD			
	Mustang	std	
	Tempo	opt	
	Taurus	std	
	Crown Victoria	std	
LINCOLN			
	Town Car	std	std
	Mark VII	std	
	Continental	std	std
MERCURY			
	Capri	std	
	Topaz	std	
	Sable	std	
	Grand Marquis	std	
OLDSMOBILE			
	88 Royale Sdn	opt	
	Cust. Cruiser	std	
	98	std	
	Toronado	std	
PLYMOUTH			
	Acclaim	std	
	Sundance	std	
PONTIAC			
	Firebird	std	
IMPORTS			
ACURA			
	Legend	std	opt
	NSX	std	
ALFA ROMEO			
	All	std	
AUDI			
	All	std	
BMW			
	All	std	
GEO			
	Metro	std	
	Storm	std	
INFINITI			
	M30	std	
	Q45	std	—
ISUZU			
	All	std	
JAGUAR			
	XJ-S	std	
LEXUS			
	All	std	
MAZDA			
	MX-5 Miata	std	
	RX-7 Conv	std	
MERCEDES-BENZ			
	190 Series	std	
	300 E/SL	std	std
	300 Series	std	opt
	350 Series	std	opt
	420 Series	std	std
	500 Series	std	std
	560 Series	std	std
MITSUBISHI			
	3000GT	std	
NISSAN			
	300ZX	opt	
PORSCHE			
	944	std	std
	911	std	opt
	928	std	std
SAAB			
	All	std	
TOYOTA			
	Celica	std	
	MR2	std	
	Supra	std	
VOLKSWAGEN			
	Cabriolet	std	
VOLVO			
	All	std	

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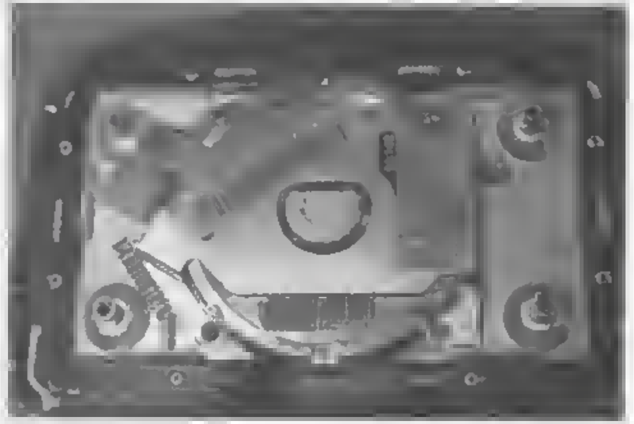

Air bag modules are generally fastened to the center of the vehicle's steering column with four bolts. A thin tin plate covers the components of the module. It must be cut away with tin snips, exposing detonator chamber and air bag. Do not damage the white nylon electrical plug shown at upper left.

nisms are disarmed and then disconnect the air bag electrical connection behind the bag module on the steering column. This is a simple safety-snap electrical connection.

Remove the four bolts holding the module in place. These are said to be special bolts but appear to be common, garden-variety fasteners.

The air bag unit with deployment module will now be free of the vehicle. This module is made to be replaced, so removal should not be a problem.

Turn the module over on its soft plastic face and observe the back of the unit. A piece of thin tin, fastened with four rivets, will protect the gas-generating portion of the module. Cut away this tin plate, exposing the back of the module. An aluminum Big Mac-like detonating chamber will be

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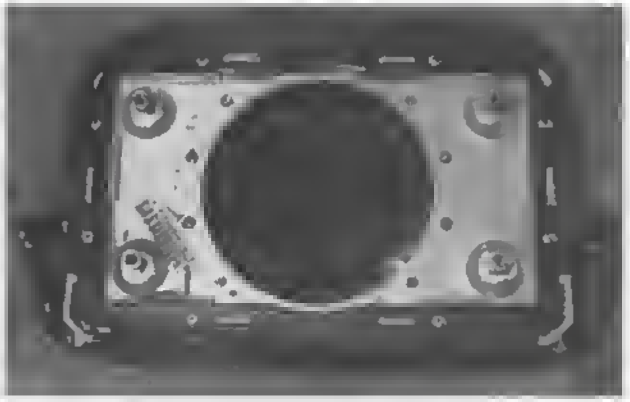
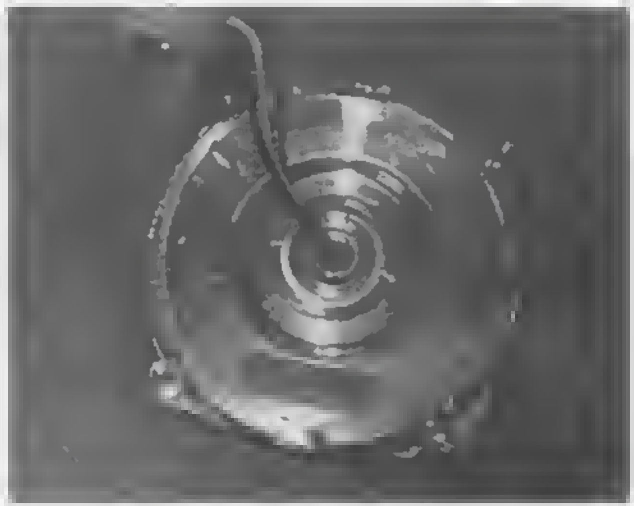
Front view of air bag module separated from vehicle.

After tin shield is removed, the heavy aluminum detonating chamber can be seen. Four rivets, one in each corner, secure this piece to the air bag. Grind off the rivets and separate.



Throw away the remaining air bag portion of the module.

The aluminum detonating chamber is die-stamped together and cannot be disassembled nondestructively. The screened holes allow gas into the air bag.



The electrical detonating cap is pressed into the aluminum assembly. Grind on second ring to remove, but do so carefully, as the cap is fragile.

obvious. This must be separated from the folded air bag.

Grind off the four rivets holding this heavy aluminum chamber to the air bag. Pop out the aluminum chamber and dispose of the remaining air bag assembly. Be sure to recycle.

This remaining aluminum sandwich contains the detonator cap and sodium azide pellets. It is permanently die-pressed together and built like a German bunker. There is absolutely no way to disassemble without totally destroying the unit. Fortunately, everything is made of aluminum so that one can hacksaw through with some impunity.

The electrical cap itself is quite large—about 3/4 inch across. It is permanently wedged into the aluminum Big Mac and must be ground out. Carefully grind away the

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Cut the side from the detonation chamber, exposing sodium azide pellets.

Parts removed in getting to the sodium azide pellets.

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Pour pellets from chamber into a container.

outer edge of the assembly. Pull the cap free by the wires. Be sure to grind on the outer lip of the cap so as to remove the entire unit.

The cap body is quite frail and will deform easily if one is not cautious. Try not to kink or otherwise damage the electrical wires.

The sodium azide pellets are removed by cutting down through the aluminum body across one end. Cutting through the die-stamped compressed aluminum unit was time consuming but not unduly rigorous. Break and cold chisel through till all of the screens and barriers are open. Pour the pellets out. Since we were initially uncertain regarding the explosive power and sensitivity of sodium azide, we took the pellets out before other disassembly and exploration.

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Sodium azide pellets are rather inert and of little practical value that we could discover. When thrown into a stove, they eventually cook off with a burst of smoke and heat. They won't go off from concussion, nor will they perform meaningful work by themselves or when mixed with Bullseye, ammonium nitrate, or black powder.

On complete disassembly of the cap, we discovered about 15 grains of powder, which looked suspiciously like 4F black. This powder was not impact-sensitive but burned nicely in the stove. Since the cap was in pieces, it could not be tested on a stick of dynamite.

Our gut intuition is that this cap would be too thick and wimpy all by itself to be a good, reliable detonator. Perhaps it would work with a few pellets of sodium azide taped to it, but we do not know.

For this and several other reasons, it seems that air bag components will not be the first choice for improvised dynamite caps. But one should not give up hope. Congress may pass a law forcing car manufacturers to improve these units using hotter caps. In this environment, anything can happen.

Conclusion

Even those with the mechanical aptitude of a cocker spaniel can, by breaking this process down into its component parts, eventually come up with adequate, serviceable, high-explosive detonators. Home-builders can put their caps together for about 40 cents each. Commercial caps run from 90 cents each for the common type up to $1.75 for the more exotic, delayed-action varieties.

After one gets on to it, procedures involved with home manufacture of detonators are not all that time-consuming or difficult. The obvious question then: is one better served financially, legally, socially, and physically by making his own detonators? After all, this is the era of the do-it-yourself approach. If hairy-legged yogurt eaters can find fulfillment making their own bread, can the survivor not do the same making his own explosives, detonating caps, and triggering devices? Yet high explosives must, by nature, be much more precise and exacting than the average loaf of homemade bread.

Some observers never seem to get it right that explosives are extremely precise. The uninformed—who seem to get all of their information regarding explosives from TV and movies—tend to assume that destructive forces from high explosives are uncontrollable and unpredictable, when in fact the absolute opposite is true. Professionals spend a great deal of time and energy doing precise calculations as to the exact amount of explosives needed for a given situa-

tion. Explosives engineers have, for instance, used commercial dynamite to shatter solid rock 3 inches from a high-pressure gas main.

A good example of this occured during one of the last truly huge detonations in which I participated. It involved shooting a 12-foot seam of rock under a 3-acre field covered by about 3 feet of rocky, sandy, semiconsolidated overburden. The goal was to loosen the top material while shattering the rock beneath so that everything could be handled with rubber-tired front-end loaders. After the shot, the quarry owners wanted to scrape away the 3-foot layer of pebbly soil and stockpile it for future use. They specified that the 12 feet of rock was to be sufficiently shattered so that it would feed through a 16-inch griselly (rock sieve) into the primary rock crusher.

We spent the better part of a week with a 2-inch compressed air drill boring down through the top layer into the solid rock below. Spacing for these shot holes was the subject of a great deal of mental gymnastics. The work had to be done correctly the first time. There was no going back if the shot was not sufficiently powerful. Failure to loosen all of the overburden or thoroughly shatter the rock below would result in costly, time-consuming work with expensive bulldozers. Use of too much powder, on the other hand, would also be costly and would hopelessly mix the overburden and shattered rock.

After all of the holes were drilled, we went back with a specially designed air device and blew previously prepared ammonium nitrate into the shot holes. This ammonium nitrate came premixed from the factory with powdered walnut hulls and diesel fuel. (It is referenced in the trade as a blasting agent. It's cheaper than dynamite, with not too much less ability to do the work. The material's greatest drawback is its lumpy, clumpy nature when temperatures get to 40°F and below.)

The shot holes were filled with the ammonium nitrate mixture to within a foot of the top of the rock layer, a 1/10-second-delay electrical blasting cap installed, and then a foot of sand blown in, filling the hole in the rock.

Above the rock on top of the foot of sand fill we placed an additional 14 inches of explosive. This was capped with a real-time "immediate cap." The plan was to lift and break up the top material for a microsecond while the rock below was forcefully shattered. Without the weight of the material above, shatter action in the rock below would be much better. (The term in the industry is to use a "relieving charge.")

Totally, more than 200 separate shot holes were placed using two detonator caps each. About 8,000 pounds of explosive went into the project.

A great number of friends, bystanders, and inquisitive acquaintances watched as we hooked our 220-volt motor generator to the drop wires. We opened the throttle on the generator, blew a long blast on the car horn, and threw the switch.

Results, from a powder monkey's viewpoint, were dramatic. As if thrown up by a giant hand, the entire field fluffed upward a bit. There was a lot of dust but only a minor amount of movement. No sharp blast and no geysers in the sky. It sounded as though someone dropped a cow from a four-story building onto the cement. It was a dull thump at most.

I watched with great satisfaction. It was a completely successful shot, graphically demonstrating how high explosives are used wisely. No powder was wasted. Results were exactly as specified. Nonetheless, a fellow standing near turned, shaking his head. "What a disaster," he shouted. "What are you going to do now?" He was erroneously conditioned to expect a mighty roar, with tons of rock hurtling hundreds of feet into the air.

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Explosives can and should be used in a very precise manner. Since it is virtually impossible to make consistent, precise primers and powder at home, I don't do either; I purchase all of my blasting supplies commercially. If ever I had to use totally homemade explosives, I probably could. But right now, concerns about holding variables to an absolute minimum, personal safety, and doing a good, professional job override any other requirement pertaining to explosives.

Home manufacture of primary detonators has always been a mystery, whereas explosive manufacture is relatively straightforward. Now, readers have the information to do the whole process from start to finish. They can, if they must, home-manufacture explosives and detonators that are effective and somewhat predictable.